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Medical Systems Engineering to Support Mars Mission Crew Autonomy

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Human spaceflight missions to Mars face exceptionally challenging resource limitations that far exceed those faced before. Increasing transit times, decreasing opportunity for resupply, communications challenges, and extended time to evacuate a crew to definitive medical care dictate a level of crew autonomy in medical care that is beyond the current medical model. To approach this challenge, a medical systems engineering approach is proposed that relies on a clearly articulated Concept of Operations and risk analysis tools that are in development at NASA. This paper proposes an operational clinical model with key terminology and concepts translated to a controls theory paradigm to frame a common language between clinical and engineering teams. This common language will be used for design and validation of an exploration medical system that is fully integrated into a Mars transit vehicle. This approach merges medical simulation, human factors evaluation techniques, and human-in-the-loop testing in ground based analogs to tie medical hardware and software subsystem performance and overall medical system functionality to metrics of operational medical autonomy. Merging increases in operational clinical autonomy with a more restricted vehicle system resource scenario in interplanetary spaceflight will require an unprecedented level of medical and engineering integration. Full integration of medical capabilities into a Mars vehicle system may require a new approach to integrating medical system design and operations into the vehicle Program structure. Prior to the standing-up of a Mars Mission Program, proof of concept is proposed through the Human Research Program.

I. BACKGROUND

Context

NASA exploration context, Conceptual drivers review,

Motivation

Text here – mention OIG, IOM reports
-interface challenges from purpose chart 3
-no existing way to identify and manage

Purpose and Scope

Follow on paper to last years with a focus on the third conceptual driver – medical system design and integration

II. APPROACH

Describe approach here.

III. METHODS

Discuss what we did for each of the steps in the approach. Just use ExMC examples for continuity with other talks in session.

IV. OUTCOMES

Outcomes specific to the example data – how was systems engineering stood up, how did it merge with medical clinical team, what common terminology and validation was agreed upon, pros and cons of this approach

V. FUTURE WORK

Possibly discuss integration and early testbed efforts to integrate medical data architecture with IPAS, HIVE, etc.

VI. CONCLUSIONS

Demonstrated medical capability to speak systems engineering language, common SysML model approach is set, data movement is first target of medical system validation, medical simulation as a tool for system validation is a new requirement.

Established tools to support subsequent HRP solicitation development process.

REFERENCES

1) Conceptual Drivers paper
2) Strategic Risk Paper
3) Others

A1.3. Medical Care for Humans in Space

This session focuses on medical care for astronauts including operational medicine aspects, countermeasure development and applications as well as needs for future care for astronauts during long term stays in space and missions to and on the Moon and Mars. A further focus will lie on medical care for passengers and operators of commercial suborbital and orbital space flights.

Co-Chair

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